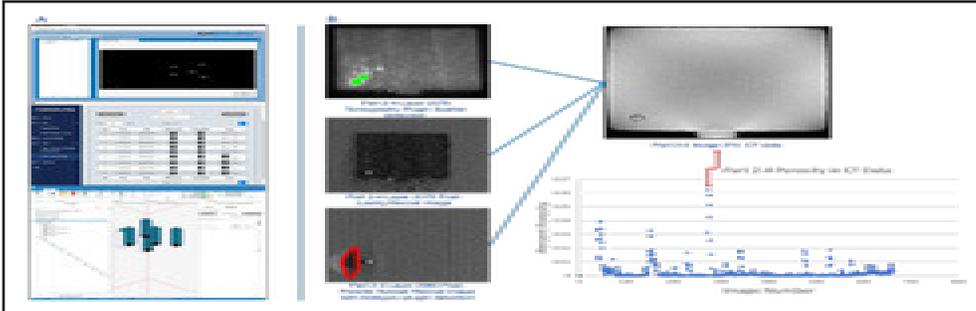


SUCCESS STORY

The retrained model significantly reduced the false positive and negative rates while raising the overall sensitivity of the model.

Provided critical foundation for in-situ sensing and analytics towards the end goal of in-situ part certification.



The basis of in-situ certification showing the recoat plugin running concurrently with AMSENSE and the build (left); detected thermal and recoat anomalies, the resultant CT image, and porosity analysis (right).

PROBLEM

Adoption and proliferation of metal additive manufacturing (AM), particularly laser powder bed fusion (LPBF), has been hindered by the difficulty of ensuring adequate process control and quality parts without extensive and expensive post-build inspection methods. It is thus well recognized that in-situ process monitoring has the potential to significantly reduce production costs by enabling real-time alerts for builds that result in low-quality parts or failed builds and by reducing or even eliminating certain post-build inspections. These in-situ monitoring solutions however have been limited in their ability for end users to develop and deploy customized analytics.

OBJECTIVE

The objective of this program was to apply a developed recoat algorithm for greater access to in-situ data and resulting analytics. Specifically the program sought to provide live and actionable process stability insights to end users through the merger of the developed open-architecture sensing and analytics platform developed by Open Additive, LLC which offers a multi-sensor data collection and analysis suite.

TECHNICAL APPROACH

The project team was led by Open Additive and also included Addiguru and Wright State University. Open Additive has commercialized a multi-sensor data collection and analysis suite (AMSENSE) offered as an option on its own open-architecture LPBF systems and also as an add-on for industrial systems in both research and development and production settings. It was designed from the outset to provide a more open approach to sensing and analytics. The team identified all details of the plugin interface necessary to transition it from Open Additive's open-architecture LPBF system and designed a series of builds to collect the data necessary to train Addiguru's model, understand the material response, and characterize the other in-situ data. The results of these tasks were then leveraged in a demonstration build of the recoat plugin running in a relevant environment with post process analysis of the collected data.



**AMERICA MAKES
TECHNOLOGY
DEVELOPMENT
ROADMAP**

This project aligns to:



VALUE CHAIN

**ASTM
PROCESS CATEGORY:**
Powder Bed Fusion

MATERIAL:
Inconel 718

ACCOMPLISHMENTS

The recoat analytic successfully identified the types and quantities of recoat anomalies that are relevant in an industrial environment. The retrained model significantly reduced the false positive and negative rates while raising the overall sensitivity of the model. This increased sensitivity is an important enabler of future features in the software which would allow operators to turn down the sensitivity to arrive at a desired level on a part, material, or process level. Successful demonstration of connecting the presence of bright, localized anomalies in the thermal tomography data to indications in the post-lasing and post-spread images to defects in the material is a key steppingstone to the eventual use of in-situ sensing and analytics as a nondestructive evaluation technique. There is still work to be done as shifting from correlations to true probability of detection with respect to a defect of a certain size is a big effort. The use of multiple sensor modalities is an improvement in the maturation of in-situ sensing and analytics technology as the orthogonal data streams provide additional information to either confirm or deny the presence of a material defect. With the implementation of holistic homography across all sensing modalities, the integration of the spatter analytic would be another valuable tool against unwanted defects.

PROJECT END DATE

May 28, 2021

DELIVERABLES

- Powder specification
- Microstructural analysis results
- Process parameters and associated files for LPBF builds
- AI/ML analysis of sensor data sets
- Multi-sensor in-situ data files
- Final report

All downloadable deliverables are available to members of America Makes via the Digital Storefront.

FUNDING

\$225,364 total project budget

(\$150,000 public funding/\$75,364 private funding)

PROJECT PARTICIPANTS

Project Principal:

Open Additive, LLC

Other Project Participants:

Addiguru

Wright State University

Public Participants:

U.S. Department of Defense

5001.001.001.004 Open Analytics Platform for Multi-Sensor In-Situ Monitoring

NCDMM Headquarters

486 Cornell Road
Blairsville, PA 15717
Phone: (724) 539-8811

ncdmm.org

Letterkenny Offices

4755 Innovation Way
Chambersburg, PA 17201
Phone: (717) 553-0068

America Makes Offices

236 West Boardman Street
Youngstown, OH 44503
Phone: (330) 622-4299

AmericaMakes.us